Consommation
et Corporations Canada

Bureau des brevets

Ottawa, Canada
K1A 0C9

Consumer and
Corporate Affairs Canada

Patent Office

(21) (A1) 2,068,574
(22) 1992/05/13
(43) 1992/12/02

5,064,3/56

(51) INTL.CL.[5] H01J-061/52

(19) (CA) APPLICATION FOR CANADIAN PATENT (12)

(54) Irradiation Device Having a High-Power Radiator

(72) von Arx, Christoph - Switzerland ;

(73) Asea Brown Boveri Ltd. - Switzerland ;

(30) (EP) 91108988.6 1991/06/01

(57) 5 Claims

Notice: The specification contained herein as filed

TITLE OF THE INVENTION

Irradiation device having a high-power radiator

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to an irradiation device having a high-power radiator, especially for ultraviolet light, having a discharge space, which is filled with filling gas emitting radiation under discharge conditions and the walls of which are formed by a first and a second dielectric, which is provided, on its surfaces facing away from the discharge space, with first metallic lattice-type or grid-type and second electrodes, having an alternating current source, connected to the first and second electrodes, to feed the discharge.

In this case, the invention makes reference to prior art as is disclosed, for example, in EP-A 0,254,111.

Discussion of Background

The industrial application of photochemical processes is to a great extent dependent upon the availability of suitable UV sources. The conventional UV radiators give low to medium UV intensities at certain discrete wavelengths, such as, for example, low-pressure mercury lamps at 185 nm and especially at 254 nm. Really high UV power levels are obtained only from high-pressure lamps (Xe, Hg), which, however, then distribute their radiation over a greater wavelength range. The new excimer lasers have made some new wavelengths available for photochemical fundamental experiments, but at the present time, for reasons of cost, are suitable for an industrial process really only in exceptional cases.

A novel excimer radiator is described in the initially mentioned EP Patent Application, or also in the conference publication "Novel UV and VUV Excimer

Radiators" by U. Kogelschatz and B. Eliasson, distributed at the 10th lecture conference of the Association of German Chemists, Photochemistry Technical Group, in Würzburg (FRG) on 18-20 November 1987. This novel type of radiator is based on the principle that it is also possible to generate excimer radiation in silent electrical discharges, a type of discharge which is employed in the production of ozone on an industrial scale. In the filaments of current, which exist only for a short time (< 1 microsecond), of this discharge, rare-gas atoms are excited by electron collision, which atoms further react to form excited complexes of molecules (excimers). These excimers have a life of only a few 100 nanoseconds, and, upon disintegration, give up their binding energy in the form of UV radiation.

Even as far as the power supply, the construction of such an excimer radiator corresponds to a large extent to that of a conventional ozone generator, with the essential difference that at least one of the electrodes and/or dielectric layers bounding the discharge space transmits the generated radiation. At least one of these electrodes might shade off the generated radiation only to a slight extent. A further requirement imposed upon the radiator is that, even at high power densities, it too should radiate as little heat as possible. This is particularly important in applications in the graphics industry, where printing inks frequently have to be hardened on a heat-sensitive background.

SUMMARY OF THE INVENTION

Proceeding from the prior art, the object of the invention is to provide an irradiation device having a radiator, especially for UV or VUV radiation, the electrodes of which shade off the radiation as little as possible and which radiator can optimally be cooled.

In order to achieve this object, it is provided according to the invention that the radiator is immersed in a coolant bath, in such a manner that the coolant flows around the first dielectric and at least the first electrodes, and that at least one wall of the coolant bath and the coolant itself transmit the generated radiation.

An irradiation device constructed in this manner satisfies all requirements encountered in practice:

- The invention permits the construction of an entirely cold radiator; this is especially important in connection with the hardening of printing inks on a heat-sensitive background.
- The outer electrodes can be of simple construction - it is sufficient to provide a few metal strips or metal wires which extend in the longitudinal direction of the radiator and which do not necessarily need to rest on the outer dielectric. In this manner, the dielectrics can readily be exchanged.
- The coolant, preferably water, prevents external discharges between the outer electrodes and outer wall of the radiator. This prevents the formation of ozone.
- As no further external discharges can develop, metal deposition by sputtering is also prevented, i.e. the UV transmittance is not impaired, even after a relatively long period of operation.
- In the event that the respective application permits operation only with a coolant bath sealed off on all sides and the UV radiation can leave said bath only through a window, the latter can readily be cleaned or exchanged. This is significant for the use of the radiator in the graphics industry, where it is frequently the case that ink residues have to be removed.
- The invention permits not only a strictly modular

construction, but also the integration of a plurality of radiators within the same bath.

A first advantageous development of the subject of the invention comprises providing the walls of the coolant bath with a layer which reflects the UV radiation well, or, in the case of walls composed of aluminum or an aluminum alloy, polishing said walls. A further variant comprises providing a part of the outer surface of the outer dielectric tube with a UV-reflecting layer. Yet a further variant provides the incorporation, in the coolant bath, of a separate reflector which is designed so that a considerable part of the UV radiation generated by the radiator leaves the bath without said radiation having to pass the actual radiator once again.

In all these variants, the coolant bath can also be utilized for the cooling of the electrical and electronic components of the current source for feeding the radiator, e.g. in that the parts to be cooled are mounted directly on the outer walls.

Particular refinements of the invention and the further advantages attainable thereby are explained in greater detail hereinbelow with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing, which shows embodiments of a high-power irradiation device in a highly simplified form, and wherein:

Fig. 1 shows an irradiation device having a UV cylinder radiator which is immersed in a coolant bath, and in which radiator the UV radiation can penetrate to the exterior through a window;

Fig. 2 shows a longitudinal section through the device according to Fig. 1, along the line AA therein;

Fig. 3 shows a modification of the device according to Fig. 1, having a separate reflector in the coolant bath.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, in Figures 1 and 2 there is presented a diagrammatic representation of an irradiation device which comprises a UV high-power radiator having an outer dielectric tube 1, e.g. of quartz glass, an inner dielectric tube 2, which is disposed concentrically thereto and the inner wall of which is provided with an inner electrode 3. The annular space between the two tubes 1 and 2 forms the discharge space 4 of the radiator. The inner tube 2 is inserted in a gas-tight manner into the outer tube 1, which was filled, in advance, with a gas or gas mixture which, under the influence of silent electrical discharges, emits UV or VUV radiation. The outer electrode 5 employed is a wide-mesh metal grid, or the latter consists of individual metal wires or metal strips which extend in the longitudinal direction of the tube, which grid extends over approximately the upper half-circumference of the outer tube 1. In the case of a strip-type electrode arrangement, the individual strips are connected to one another at a plurality of axially distributed points. Both the outer electrode 5 and also the outer dielectric tube 1 transmit the generated UV radiation. The lower circumference of the tube 1 is provided with a reflector 6. This can, for example, be formed by a vapor-deposited aluminum layer. This reflector is at the same electrical potential as the outer electrode 5.

The radiator which has just been described is immersed in a coolant bath 10, which is bounded by

metal walls 7, 8, 9, 17 and 18 and through which, via coolant inlet 11 and coolant outlet 12 respectively, coolant, preferably distilled water, flows. A UV-transmitting window 13, e.g. of quartz glass, is provided in the upper part.

Another possibility for directing the created radiation in a preferred manner through the window 13 into the outer space comprises mirror-coating the internal surface of the walls 7, 8 and 9; in the case of aluminum walls, this can take place by polishing the surfaces. For the mirror-coating of the vessel walls, a preferred embodiment optionally provides for the insertion of a separate reflector 14 into the floor portion of the bath, which separate reflector exhibits a multiplicity of perforations 15 and is at the same electrical potential as the vessel walls. The perforations permit an adequate coolant flow from the inlet 11 to the outlet 12. The reflector 14 is formed so that it reflects a major part of the UV light emitted downwards by the radiator, without the radiation having to pass the dielectric tube or indeed the two dielectric tubes 1 and 2 once again. The cross-section of the reflector 14 can be considered as being composed of two parabolic sections.

The electrodes 3 and 5 are passed to the two terminals of an alternating current source 16. The alternating current source 16 corresponds, fundamentally, to those which are used for supplying ozone generators. Typically, it delivers an adjustable alternating voltage in the order of magnitude of several 100 volts to 20,000 volts at frequencies within the range of industrial alternating current, reaching up to a few thousand kHz - depending upon the electrode geometry, the pressure in the discharge space 4 and the composition of the filling gas.

The filling gas is, for example, mercury, a rare gas, rare gas/metal vapor mixture, rare gas/halogen mixture, possibly with the use of an

additional further rare gas, preferably Ar, He or Ne, as buffer gas.

Depending upon the desired spectral composition of the radiation, it is in this case possible to use a substance/mixture of substances according to the following table:

Filling gas	Radiation
Helium	60 - 100 nm
Neon	80 - 90 nm
Argon	107 - 165 nm
Argon + Fluorine	180 - 200 nm
Argon + Chlorine	165 - 190 nm
Argon + Krypton + Chlorine	165 - 190, 200 - 240 nm
Xenon	160 - 190 nm
Nitrogen	337 - 415 nm
Krypton	124, 140 - 160 nm
Krypton + Fluorine	240 - 255 nm
Krypton + Chlorine	200 - 240 nm
Mercury	185,254,320-370,390-420 nm
Selenium	196, 204, 206 nm
Deuterium	150 - 250 nm
Xenon + Fluorine	340 - 360 nm, 400 - 550 nm
Xenon + Chlorine	300 - 320 nm

In addition to the above, a whole series of further filling gases may be considered:

- A rare gas (Ar, He, Kr, Ne, Xe) or Hg with a gas or vapor consisting of F_2, I_2, Br_2, Cl_2 or a compound which in the discharge splits off one or more F, I, Br or Cl atoms;
- a rare gas (Ar, He, Kr, Ne, Xe) or Hg with O_2 or a compound which in the discharge splits off one or more O atoms;
- a rare gas (Ar, He, Kr, Ne, Xe) with Hg.

In the silent electrical discharge which is formed, the electron energy distribution can be optimally set by the thickness of the dielectrics 1 and 2 and their pressure and/or temperature properties in

the discharge space 4.

Upon application of an alternating voltage between the electrodes 3 and 5, a multiplicity of discharge channels (partial discharges) is formed in the discharge space 4. These enter into interaction with the atoms/molecules of the filling gas, which leads, in the final analysis, to the UV or VUV radiation.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:-

1. An irradiation device having a high-power radiator, especially for ultraviolet light, having a discharge space, which is filled with filling gas emitting radiation under discharge conditions and the walls of which are formed by a first and a second dielectric, which is provided, on its surfaces facing away from the discharge space, with first metallic lattice-type or grid-type and second electrodes, having an alternating current source, connected to the first and second electrodes, to feed the discharge, wherein the radiator is immersed in a coolant bath (10), in such a manner that the coolant flows around the first dielectric (1) and at least the first electrodes (5), and wherein at least one wall (13) of the coolant bath (10) and the coolant itself transmit the generated radiation.

2. The high-power radiator as claimed in claim 1, wherein the walls (7, 8, 9) of the coolant bath (10) are provided with a layer which reflects UV radiation well, or, in the case of walls (7, 8, 9) composed of aluminum or an aluminum alloy, said walls are polished.

3. The high-power radiator as claimed in claim 1, wherein a part of the outer surface of the outer dielectric tube (1) is provided with a UV-reflecting layer (6).

4. The high-power radiator as claimed in claim 1 or 2, wherein a separate reflector (14) is incorporated in the coolant bath (10), which separate reflector is designed so that a considerable part of the UV radiation generated by the radiator leaves the coolant bath (10) without said radiation having to pass the actual radiator once again.

5. The high-power radiator as claimed in one of claims 1 to 4, wherein the coolant bath (10) can also be utilized for the cooling of the electrical and

electronic components of the current source to feed the radiator.

ABSTRACT OF THE DISCLOSURE

In order to improve the cooling of an irradiation device having a UV high-power radiator, the latter is entirely immersed in a coolant bath (10), the bath and at least one wall (13) of the bath being transparent to the generated UV radiation.

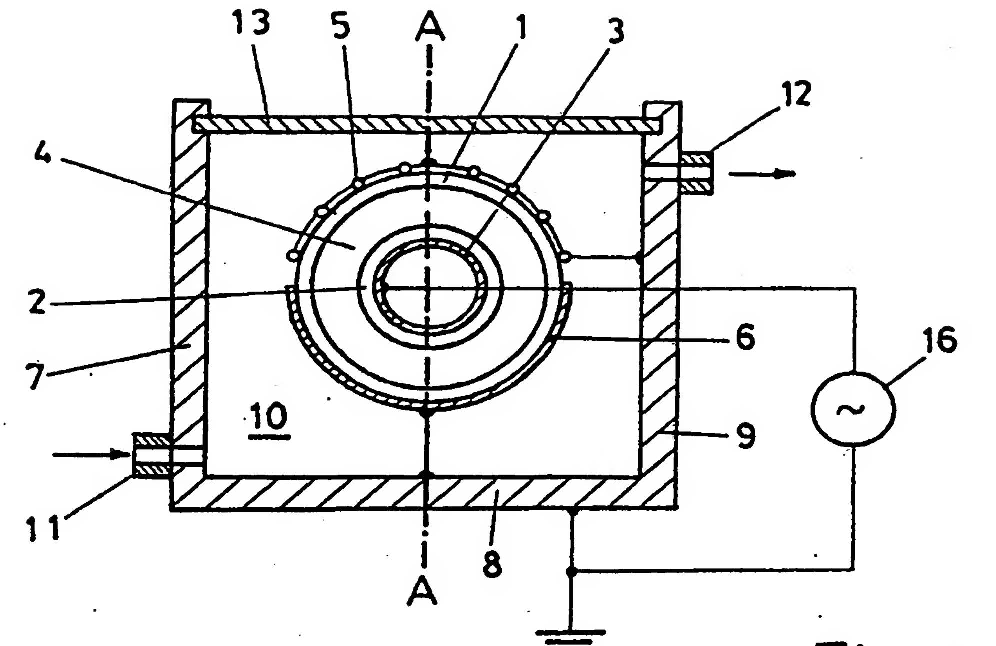

Fig. 1

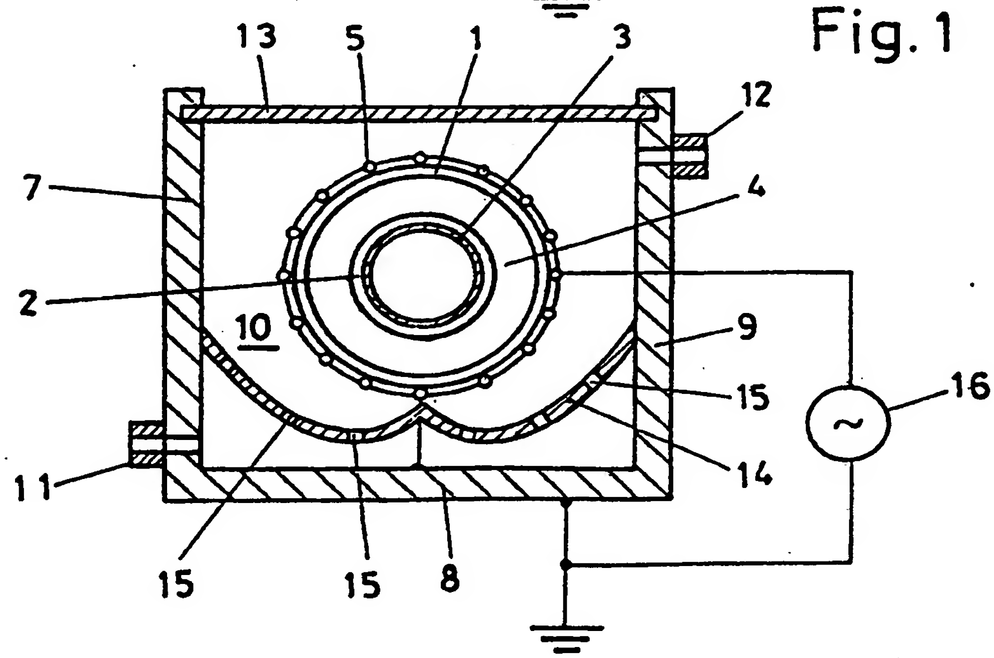

Fig. 3

PATENT AGENTS

Swabey Ogilvy Renault

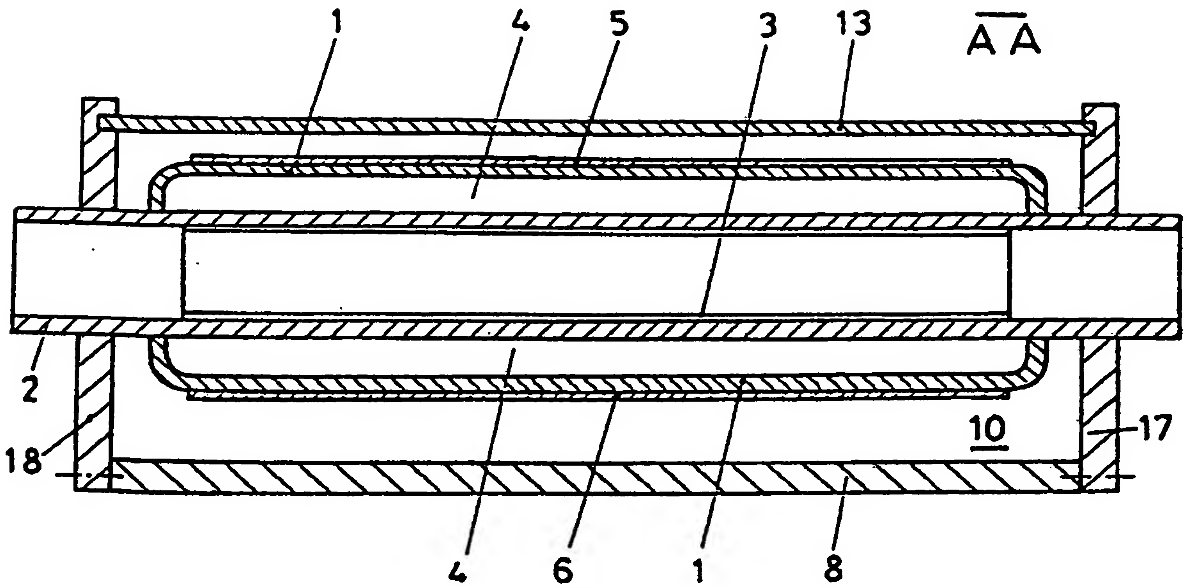

Fig.2

PATENT AGENTS

Swabey Ogilvy Renault

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☑ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: ______________________________

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.